$$
\begin{aligned}
A &= 1, \\
B &= -\frac{1}{3}, \\
C &= \frac{2}{5}B = -\frac{2}{3.5}, \\
D &= \frac{4}{7}C = -\frac{2.4}{3.5.7}, \text{ \&c.};
\end{aligned}
$$

whence substituting in (4) and (3), integrating, and observing that $c=0$ when $t=0$ or $x=\infty$, we have the series (2). On substituting now in succession $\tan^{-1}\frac{1}{3}$ and $\tan^{-1}\frac{1}{7}$ for c, and therefore 10 and 50 for x, and in the latter case multiplying the numerators and denominators of the successive terms by successive powers of 2, we obtain the series (1).

These series, which the author believes to be new, follow a simple law, and converge with great rapidity. But their distinctive feature, compared with other series which have been given for the same object, consists in the fact that the denominators involve the successive powers of 10, the division by which is effected at once.

II. "On the Production of Vibrations and Sounds by Electrolysis." By George Gore, Esq. Communicated by Professor Tyndall. Received November 12, 1861.

(Abstract.)

In this communication, which is a continuation in subject (but different in title) of a previous investigation "On the Movements of Liquid Metals and Electrolytes in the Voltaic Circuit," the author has described the most convenient and effective method of obtaining vibrations and sounds by electrolysis.

The paper contains a full account of the influence of various circumstances upon the vibrations and sounds: viz., of the electrodes,—the electrolyte,—mechanical circumstances and temperature,—the electric current,—size and number of voltaic elements,—quantity of the current,—coils of wire in the circuit,—induction coils and iron cores,—electrolytes in the circuit,—and of magnetism: also the influence of the vibrating medium itself upon the electric current.

The best liquid for producing the vibrations and sounds consists of

10 grains of cyanide of mercury and 100 grains of hydrate of potash dissolved in $2\frac{3}{4}$ ounces of aqueous hydrocyanic acid containing 5 per cent. of anhydrous acid.

The vibrations and sounds occur only at the surface of the negative mercury electrode, as already described (Proc. Roy. Soc. No. 44, page 177); and out of a large number of liquids examined, the only ones in which *phonetic* vibrations occurred were solutions of alkaline cyanides containing dissolved mercury; and these only give the sounds with electrodes (or at least a cathode) of mercury, not with solid metals nor with fused alloys.

The vibrations and sounds vary considerably according to the size and number of the voltaic elements; with a few elements of large surface, the vibrations were small and the sounds high, and with many elements of small surface they were much larger and the tone lower. The most suitable number of elements to produce them is either two of Grove's or five of Smee's.

The interposition of a coil of stout copper wire in the circuit made the vibrations wider and the sound more base; and if an iron core was suddenly thrust into the axis of the coil, they became still wider and the sounds still more base, and remained so as long as the iron continued there; but if a secondary coil containing a great length of fine copper wire surrounded the primary coil (with or without an iron core), and the ends of the secondary wire were suddenly united, the vibrations instantly became narrower and the sounds more high, and remained so as long as the secondary circuit was closed.

The vibrations of the mercury and electrolyte make the electric current which produces them sensibly *intermittent*, similar to the influence of a vibrating coil-hammer; and they may be used to some extent in a similar way to that instrument to produce shocks, &c. by means of a secondary coil. A strong electro-magnet placed in various positions near the locality of the vibrations had no perceptible influence upon them.

The author considers the vibrations to be of *electro-chemical* origin, and to result from an attraction between the mercury of the negative electrode and the mercury of the electrolyte. He supposes that to produce the vibrations, either the voltaic force itself must be of an intermittent nature, or the resistance opposed to that force by the liquids employed must be intermittent, and intends to make the

experimental investigation of this question, with other allied matters, the subject of a future communication.

III. "On Perchloric Acid and its Hydrates." By HENRY ENFIELD ROSCOE, B.A., Ph.D., Professor of Chemistry in Owens College, Manchester. Communicated by Professor A. W. WILLIAMSON. Received December 12, 1861.

Stadion* in the year 1816 showed that perchlorate of potassium contains 45·92 per cent. of oxygen, and that its composition is therefore represented by the formula $Cl\,\Theta_4\,K$ (requiring 46·17 per cent. of oxygen). Mitscherlich† and Serullas‡ in 1830, and Marignac§ in 1841, confirmed this result, their experiments respectively showing that the salt in question contains 46·06, 46·20, and 46·17 per cent. of oxygen.

Upon these determinations is based nearly all the knowledge we possess of the quantitative relations of perchloric acid. The anhydride, $Cl_2\,\Theta_7$, has not been isolated; no analyses of the hydrated acid itself have been published, and the composition of only one or two of its salts has been ascertained. Our acquaintance even with the general characters of this substance is also most limited; and we can only account for the neglect with which chemists have treated the highest and yet the most stable of the oxides of chlorine by the fact that the preparation of the acid in large quantity has hitherto been attended with great difficulties.

In the following communication I have to detail the results of experiments which I believe somewhat enlarge our views respecting the nature and properties of this interesting acid.

The first point to which attention was naturally directed, was the best mode of preparing the pure aqueous perchloric acid in quantity. After trial of a great number of methods, the following modification of that recommended by Serullas was adopted as yielding the best results. A large quantity of a saturated solution of hydrofluosilicic acid was prepared by heating dry sand and fluor-spar with more than the equivalent quantity of twice-rectified oil of vitriol in large stoneware bottles, and leading the gaseous fluoride of silicon with the usual

* Gilbert's Annalen, lii. pp. 197 and 339.

† Pogg. Ann. xxv. p. 287.

‡ Ann. de Ch. et de Phys. xlv. p. 270.

§ Ann. Ch. Pharm. xliv. p. 11.